

Table 1. Preliminary Screening of Ex Situ Treatment Technologies.

Treatment Technology PO	Effectiveness				Implementability	
	Site COCs Addressed	Level of Demonstration <sup>1</sup>	Demonstrated Effectiveness	Time to achieve goals	Considerations	Compatible GRA or Pre-treatment
Pre-treatment						
In-barge Dewatering	N.A.	Full-scale	Moderate to High	Days	BMPs are necessary to ensure water quality impacts are minimized.	Dredging – mechanical
Lagoon Dewatering	N.A.	Full-scale	High	Months (depending on climatic conditions)	Large staging areas are required within close proximity to the project. Dewatering could take several months depending on the percentage of fine sediment present and amount of precipitation occurring.	Dredging - hydraulic
Geotextile Tube Dewatering	N.A.	Full-scale	Moderate to High	Weeks to Months	Moderate to large staging areas are required within close proximity to the project. Dewatering could take several months depending on the percentage of fine sediment present. BMPs may be necessary to ensure air quality impacts are minimized.	Dredging – hydraulic (mechanical would require slurring)
Mechanical Dewatering	N.A.	Full-scale	High	Days	Regular equipment maintenance is required. BMPs may be necessary to ensure air quality impacts are minimized.	Dredging – mechanical or hydraulic
Reagent Dewatering	N.A.	Full-scale	Moderate to High	Days	BMPs may be necessary to ensure air quality impacts are minimized.	Dredging – mechanical
Biological Methods						
Land Treatment	TPH and PAHs	Full-scale	Low to High	Months to Years	Large staging areas are required within close proximity to the project. BMPs may be necessary to ensure air quality impacts are minimized. If air quality impacts are expected, a contained biological PO may be more appropriate. BMPs are also necessary to control contaminant migration from runoff. Bench-scale testing would be required during design.	Dredging – dewatered
Composting	PAHs	Full-scale	Low to High	Months to Years	Large staging areas are required within close proximity to the project. BMPs may be necessary to ensure air quality impacts are minimized. If air quality impacts are expected, a contained biological PO may be more appropriate. BMPs are also necessary to control contaminant migration from runoff. Bench-scale testing would be required during design.	Dredging – dewatered
Biopiles	VOCs, SVOCs, and TPH	Full-scale	Low to High	Months to Years	Regular equipment maintenance is required. BMPs are necessary to ensure air quality impacts are minimized. Bench-scale testing would be required during design.	Dredging – dewatered
Slurry-phase Treatment	VOCs and SVOCs	Full-scale	Low to High	Months	Regular equipment maintenance is required. BMPs are necessary to ensure air quality impacts are minimized. Moisture control is necessary to ensure consistent slurry concentrations are treated. Process water requires treatment and disposal. Bench-scale testing would be required during design.	Dredging – hydraulic (mechanical would require slurring)

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Physical/Chemical Methods						
Particle Separation	Metals and organics	Full-scale	Moderate to High	Days	Regular equipment maintenance is required. BMPs may be necessary to ensure air quality impacts are minimized.	Dredging - hydraulic
Blending	Low level metals and organics	Full-scale	High	Days	BMPs may be necessary to ensure air quality impacts are minimized.	Dredging – mechanical (hydraulic would require dewatering)
Cement S/S	Metals and select organics	Full-scale	Moderate to High	Days to Weeks	BMPs are necessary to ensure air quality impacts are minimized.	Dredging – mechanical (hydraulic would require dewatering)
Sorbent Clay S/S	Select organics	Bench-scale	Moderate to High	Days to Weeks	BMPs are necessary to ensure air quality impacts are minimized.	Dredging – mechanical (hydraulic would require dewatering)
Asphalt Emulsion	Metals and organics	Bench-scale	Low to Moderate	Days	BMPs are necessary to ensure air quality impacts are minimized.	Dredging – mechanical (hydraulic would require dewatering)
Sediment Washing	Metals and organics	Limited Full-scale	Moderate to High	Days	Regular equipment maintenance is required. BMPs are necessary to ensure air quality impacts are minimized. Process water and residual wastes require treatment and disposal, which could significantly increase the overall cost of treatment. Bench-scale testing would be required during design.	Dredging – hydraulic (mechanical would require slurring)
Chemical Extraction	Organics	Pilot-scale	Moderate to High	Days	Regular equipment maintenance is required. BMPs are necessary to ensure air quality impacts are minimized. Process water and residual wastes require treatment and disposal, which could significantly increase the overall cost of treatment. Bench-scale testing would be required during design.	Dredging – hydraulic (mechanical would require slurring)
Chemical Oxidation/Reduction	Metals and select organics	Pilot-scale	Moderate	Days	Regular equipment maintenance is required. BMPs are necessary to ensure air quality impacts are minimized. Process water and residual wastes require treatment and disposal, which could significantly increase the overall cost of treatment. Bench-scale testing would be required during design.	Dredging – mechanical or hydraulic
Dehalogenation	Chlorinated Organics	Pilot-scale	Moderate to High	Days	Regular equipment maintenance is required. BMPs are necessary to ensure air quality impacts are minimized. Process water and residual wastes require treatment and disposal, which could significantly increase the overall cost of treatment. Bench-scale testing would be required during design.	Dredging – mechanical (hydraulic would require dewatering)

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Thermal Methods						
Incineration	Volatile metals and organics	Full-scale	High	Days	BMPs are necessary to ensure air quality impacts are minimized. Nearest existing, permitted facility is greater than 500 miles from project. High energy consumption. Potential for dioxin generation is a concern.	Dredging – mechanical (hydraulic would require dewatering)
Pyrolysis	Organics	Pilot-scale	High	Days	BMPs are necessary to ensure air quality impacts are minimized. High energy consumption. Very low moisture content of feedstock sediment is required. Potential for dioxin generation is a concern.	Dredging – mechanical (hydraulic would require dewatering)
Thermal Desorption	PCBs, PAHs, VOCs, sVOCs, and Pesticides	Pilot-scale	Moderate to High	Days	BMPs are necessary to ensure air quality impacts are minimized. High energy consumption; however, costs may be offset through the sale/use of generated power. Pre-permitting consultation and acceptance of BU products is crucial to economic viability of PO. Potential for dioxin generation is a concern.	Dredging – mechanical (hydraulic would require dewatering)
Vitrification	Metals and organics	Pilot-scale	High	Days	BMPs are necessary to ensure air quality impacts are minimized. High energy consumption; however, costs may be offset through the sale/use of generated power or alternative energy sources (e.g., recycled tires) are identified. Pre-permitting and acceptance of BU products is crucial to economic viability of PO. May be effective in stabilizing low concentration metals. Potential for dioxin generation is a concern.	Dredging – mechanical (hydraulic would require dewatering)

Notes:

1-Includes demonstrations performed on sediment; not inclusive of upland soil or sludge.

2-Low: <\$40 per cubic yard; Moderate: \$40 to \$80 per cubic yard; High: \$80 to \$160 per cubic yard; Very High: >\$160 per cubic yard

3-Lower end of cost scale is only achievable if marketable uses are identified to support end-use products. Further evaluation based on specific remedial alternatives is required.

4-Lower end of cost scale is only achievable if marketable uses are identified to support end-use products and energy cost offsets are identified. Further evaluation based on specific remedial alternatives is required.

PO - Process Option

COCs - Contaminants of Concern

N.A. - Not Applicable

GRA - general response action

S/S - solidification/stabilization

cy - cubic yard

BU - Beneficial Use

FS - Feasibility Study

AOPC - Area of Potential Concern

Table 1. Preliminary Screening of Ex Situ Treatment Technologies.

Treatment Technology PO	Cost Considerations			Pre-FS Screening	
	Treatment Cost <sup>2</sup> (per cy)	Example BU Product; Material Disposition	Potential BU Product Demand	Determination	Rationale
Pre-treatment					
In-barge Dewatering	Low	N.A.	N.A.	RETAINED	PO is regularly implemented at a relatively low cost.
Lagoon Dewatering	Low	N.A.	N.A.	TENTATIVELY RETAINED	While this PO is regularly used to dewater sediment associated with maintenance dredging projects; these activities typically occur within permanent facilities. There is limited space available to site a facility within the project limits; however, in the event a suitable site is identified this PO was tentatively retained.
Geotextile Tube Dewatering	Low to Moderate	N.A.	N.A.	TENTATIVELY RETAINED	PO is tentatively retained although it is not regularly implemented in comparison to the other Pre-treatment POs. Geotextile tube dewatering is most applicable to sandy sediments that are hydraulically dredged.
Mechanical Dewatering	Low	N.A.	N.A.	RETAINED	PO is regularly implemented at a relatively low cost.
Reagent Dewatering	Low to Moderate	N.A.	N.A.	RETAINED	PO is regularly implemented at a relatively low cost.
Biological Methods					
Land Treatment	Low to Moderate	Regulated Fill; Industrial Sites, CDF, or Landfill Cover	Very low to low	TENTATIVELY RETAINED	PO has been successfully demonstrated on a full-scale basis, but potential siting issues must be overcome during the FS. This PO has been tentatively retained due to performance in addressing AOPC 11 COCs.
Composting	Low to Moderate	Regulated Fill; Industrial Sites, CDF, or Landfill Cover	Very low to low	TENTATIVELY SCREENED OUT	Although it is comparable to other POs, this PO is tentatively screened out because it results in a larger volume of treated material that may require disposal (e.g., amendments such as wood chips or vegetative waste).
Biopiles	Low to Moderate	Regulated Fill; Industrial Sites, CDF, or Landfill Cover	Very low to low	TENTATIVELY SCREENED OUT	Although it is comparable to other POs, this PO is tentatively screened out because implementation is more complex than other similarly demonstrated technologies. In the event an enclosed process is desirable, then biopiles may be reconsidered in the FS.
Slurry-phase Treatment	Moderate	Regulated Fill; Industrial Sites, CDF, or Landfill Cover	Very low to low	TENTATIVELY SCREENED OUT	Although it is comparable to other POs, this PO is tentatively screened out because it results in a larger waste volume (i.e., process water) and will likely be a more costly PO due to moisture control requirements during treatment.

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Physical/Chemical Methods					
Particle Separation	Moderate	Sand/Rock; Potentially Unrestricted Uses	Relatively low demand for alternative aggregate.	RETAINED	PO is regularly implemented at a relatively low cost; however, final feasibility of implementing PO requires review of grain size data.
Blending	Moderate to High	Sand/Rock; Potentially Unrestricted Uses	Relatively low demand for alternative aggregate.	TENTATIVELY RETAINED	PO is tentatively retained for use as part of a treatment train or as a finishing step prior to beneficial use. For example, treated sediment could be blended with compost to produce a manufactured topsoil. This PO may also be used to directly treat AOPCs with low-level COCs.
Cement S/S	Low to Moderate <sup>3</sup>	Regulated Fill; Industrial Sites or CDF	Very low to low	TENTATIVELY RETAINED	This PO is tentatively retained as it is a common method of stabilization that reduces the leachability of metals and select low-level organics. It is not applicable to all AOPCs as some site COCs, such as pesticides, can inhibit chemical bonding. The PO is also useful in enhancing geotechnical properties of the material for fill applications.
Sorbent Clay S/S	Moderate	Regulated Fill; CDF	Very low to low	TENTATIVELY RETAINED	PO is tentatively retained as an ex situ method due to recent positive technology demonstrations; however, it is more likely this PO would be implemented in situ. It is likely to have limited applicability to most FS alternatives.
Asphalt Emulsion	Low to Moderate <sup>3</sup>	Asphalt; Industrial Sites	Very limited	TENTATIVELY SCREENED OUT	PO is tentatively screened out based on additionally discussions with technology vendors and limited demonstrated effectiveness on sediment and site COCs.
Sediment Washing	Moderate to High <sup>3</sup>	Potential for Clean Fill; Topsoil Feedstock  Regulated Fill; Industrial Sites, CDF, or Landfill Cover	Relatively low demand for topsoil. Regulated fill has very low demand.	TENTATIVELY RETAINED	Based on review of new literature and discussions with technology vendors, PO is tentatively retained. It is likely that this PO would be implemented as part of a treatment train, rather than a stand-alone technology. Additional evaluation of specific FS alternatives is required to determine the economic viability of this PO and the potential generation of large residual waste volumes.
Chemical Extraction	High	Potential for Clean Fill; Topsoil Feedstock  Regulated Fill; Industrial Sites, CDF, or Landfill Cover	Relatively low demand for topsoil. Regulated fill has very low demand.	TENTATIVELY SCREENED OUT	Although its effectiveness is comparable to other POs on the bench-scale, this PO is tentatively screened out because it is less demonstrated on a full-scale basis than similar POs and may have limited effectiveness in treating PCBs.
Chemical Oxidation/ Reduction	High to Very High	Potential for Clean Fill; Topsoil Feedstock  Regulated Fill; Industrial Sites, CDF, or Landfill Cover	Relatively low demand for topsoil. Regulated fill has very low demand.	TENTATIVELY SCREENED OUT	PO is tentatively screened out due to limited demonstrated effectiveness in treating sediments and associated high costs. PO may also have limited effectiveness in treating PCBs.
Dehalogenation	High to Very High	Potential for Clean Fill; Topsoil Feedstock  Regulated Fill; Industrial Sites, CDF, or Landfill Cover	Relatively low demand for topsoil. Regulated fill has very low demand.	TENTATIVELY SCREENED OUT	PO is tentatively screened out due to limited full-scale demonstrated effectiveness in treating sediments and associated high costs.

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	Treatment Cost <sup>2</sup> (per cy)	Example BU Product; Material Disposition	Potential BU Product Demand	Determination	Rationale
Thermal Methods					
Incineration	High to Very High	Clean Fill; Topsoil Feedstock  Regulated Fill; Industrial Sites, CDF, or Landfill Cover	Relatively low demand for topsoil. Regulated fill has very low demand.	TENTATIVELY SCREENED OUT	While this PO is fairly well demonstrated, costs associated with the treatment and transportation to treatment facilities are very high in comparison to other thermal POs.
Pyrolysis	High to Very High	Clean Fill; Topsoil Feedstock  Regulated Fill; Industrial Sites, CDF, or Landfill Cover	Relatively low demand for topsoil. Regulated fill has very low demand.	TENTATIVELY SCREENED OUT	While this PO is fairly well demonstrated, costs associated with the treatment and transportation to treatment facilities are very high in comparison to other thermal POs.
Thermal Desorption	<i>High-Range of Moderate to Very High</i> <sup>3</sup>	Specialized Products and Fill; Non- structural Concrete Aggregate or Regulated Fill (Industrial Sites, CDF, or Landfill Cover)	Relatively low demand for specialized products/ applications. Regulated fill has very low demand.	TENTATIVELY SCREENED OUT	Although review of new literature and discussions with technology vendors indicate PO is advancing, this PO is tentatively screened out in lieu of other potentially viable thermal POs that may have a lesser chance for dioxin development. If re-retained during FS evaluations, additional evaluation of specific FS alternatives is required to determine the economic viability of this PO and to consider public concerns regarding air emissions and facility siting.
Vitrification	<i>Moderate to Very High</i> <sup>4</sup>	Specialized Products and Fill; Non- structural Concrete Aggregate or Regulated Fill (Industrial Sites, CDF, or Landfill Cover)	Relatively low demand for specialized products/ applications. Regulated fill has very low demand.	TENTATIVELY RETAINED	Based on review of new literature and discussions with technology vendors, PO is tentatively retained. Additional evaluation of specific FS alternatives is required to determine the economic viability of this PO and to consider public concerns regarding air emissions and facility siting. Considerations regarding potential dioxin development must also be addressed during the FS.

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Table 2. Preliminary Screening of In Situ Treatment Technologies.

Treatment Technology PO	Effectiveness				Implementability		Cost	Pre-FS Screening	
	Site COCs Addressed	Level of Demonstration <sup>1</sup>	Demonstrated Effectiveness	Time to achieve goals	Considerations	Compatible GRA	Treatment Cost <sup>2</sup> (per cy)	Determination	Rationale
Biological/Chemical									
Enhanced Bioremediation	PAHs and SVOCs	Pilot-scale	Moderate to High	Years	Treatment area is extensive; success is difficult to assess; does not treat all target COCs; high concentrations of chlorinated organics are toxic to beneficial microorganisms.	Enhanced Natural Recovery	Low to Moderate	TENTATIVELY SCREENED OUT	PO is tentatively screened out due to limited demonstrated effectiveness in treating site COCs.
Phytoremediation	Metals and select organics	Pilot-scale	Moderate to High	Years	Treatment area is extensive; success is difficult to assess; ingestion of vegetation is difficult to control; PO only addresses surface sediments reached by plant root system.	Enhanced Natural Recovery	Low to Moderate	TENTATIVELY SCREENED OUT	PO is tentatively screened out due to limited demonstrated effectiveness in treating site COCs.
Chemical Oxidation	Metals and organics	Pilot-scale	Moderate to High	Months	Treatment area is extensive; success is difficult to assess; may not treat all target COCs.	Enhanced Natural Recovery	High	TENTATIVELY SCREENED OUT	PO is tentatively screened out due to limited demonstrated effectiveness for sediments and associated high costs. PO may also have limited effectiveness in treating PCBs.
Contaminant Sequestration									
In Situ S/S	Metals and select organics	Pilot-scale	Low to Moderate	Months	Minimal staging areas; PO typically consists of cement or pozzolanic stabilization. Substrate homogeneity is a concern.	In-situ Containment	High	TENTATIVELY SCREENED OUT	PO is tentatively screened out due to limited technology demonstration and effectiveness in treating site COCs.
In Situ Vitrification	Metals and organics	Pilot-scale	Moderate	Months	Treatment area is extensive; moderate energy draw; success is difficult to assess; high temperature generated would likely cause water quality impacts; subsequent capping may be necessary to re-establish habitat substrate.	In-situ Containment	High to Very High	TENTATIVELY SCREENED OUT	PO is tentatively screened out due to limited demonstrated effectiveness in treating sediments and associated high costs.
Electrochemical Remediation	Metals and select organics	Pilot-scale	Low to Moderate	Months	Treatment area is extensive; equipment requires significant maintenance; moderate energy draw; success is difficult to assess; presence of buried metallic or insulating debris can impede PO.	Enhanced Natural Recovery	Moderate to High	TENTATIVELY SCREENED OUT	PO is tentatively screened out due to limited technology demonstration and effectiveness in treating site COCs.
In Situ Carbon Absorption	PCBs; potentially PAHs	Pilot-scale	Moderate to High	Months	Recent studies regarding the use of carbon-based reagents show effectiveness in adsorping PCBs. Substrate homogeneity is a concern.	Enhanced Natural Recovery	Low	RETAINED	Based on review of new literature and results of recent projects, PO is tentatively retained. Further FS alternatives evaluation is required.
Enhanced Cap Materials	Metals and select organics	Pilot-scale	Moderate to High	Weeks	Minimal staging areas; maintenance of cap materials and periodic monitoring is required.	In-situ Containment	Low	RETAINED	Based on review of new literature and results of recent projects, PO is tentatively retained. Further FS alternatives evaluation is required.

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4-Lower end of cost scale is achievable if marketable uses are identified to support end-use products and credits for energy generation are received. Further evaluation based on specific remedial alternatives is required.

PO - Process Option                      GRA - general response action                      BU - Beneficial Use

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